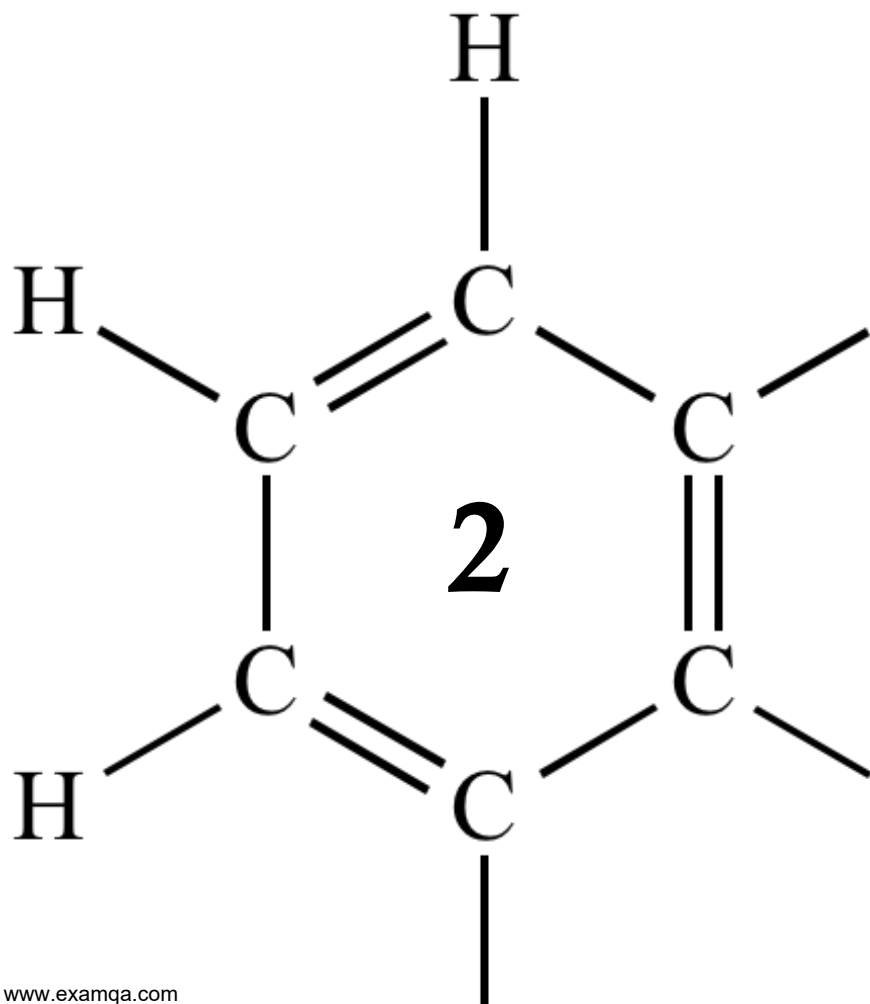


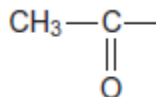
AQA A2 CHEMISTRY
ISOMERISM ~ CARBONYLS

ALDEHYDE + KETONES



1

The triiodomethane reaction is often used as a test for aldehydes and ketones that contain the CH_3CO group shown.



The aldehyde or ketone is reacted with an alkaline solution of iodine. Triiodomethane (CHI_3) is formed as a precipitate. Compounds that contain a group that can be oxidised to the CH_3CO group will also give a positive result in this test.

- (a) State, with a reason, whether or not ethanol will give a positive result in the triiodomethane reaction.

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(1)

- (b) The equation for the reaction of ethanal with an alkaline solution of iodine is



In an experiment using this reaction, the yield of triiodomethane (CHI_3) obtained by a student was 83.2%.

Calculate the minimum mass of iodine that this student would have used to form 10.0 g of triiodomethane.

Give your answer to the appropriate precision.

Show your working.

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(5)

- (c) Triiodomethane can be separated from the reaction mixture by filtration.
State **one** reason why the solid residue is then washed with water after the filtration.

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(1)

- (d) State **one** reason, other than cost or availability, why water is suitable for washing this solid residue after the filtration.

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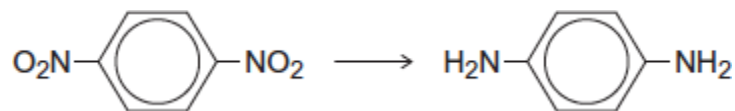
(1)

(Total 8 marks)

2

Each of the following conversions involves reduction of the starting material.

(a) Consider the following conversion.



Identify a reducing agent for this conversion.

Write a balanced equation for the reaction using molecular formulae for the nitrogen-containing compounds and [H] for the reducing agent.

Draw the repeating unit of the polymer formed by the product of this reaction with benzene-1,4-dicarboxylic acid.

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(Extra space)

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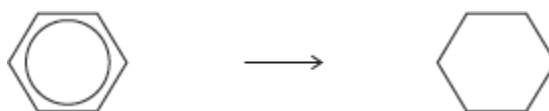
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(5)

(b) Consider the following conversion.



Identify a reducing agent for this conversion.

State the empirical formula of the product.

State the bond angle between the carbon atoms in the starting material and the bond angle between the carbon atoms in the product.

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(4)

(c) The reducing agent in the following conversion is NaBH_4



(i) Name and outline a mechanism for the reaction.

Name of mechanism

Mechanism

(5)

- (ii) By considering the mechanism of this reaction, explain why the product formed is optically inactive.

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(3)
(Total 17 marks)

4

(a) Propanoic acid can be made from propan-1-ol by oxidation using acidified potassium dichromate(VI). Propanal is formed as an intermediate during this oxidation.

(i) State the colour of the chromium species after the potassium dichromate(VI) has reacted.

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(1)

(ii) Describe the experimental conditions and the practical method used to ensure that the acid is obtained in a high yield. Draw a diagram of the assembled apparatus you would use.

Conditions

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Apparatus

(4)

(iii) Describe the different experimental conditions necessary to produce propanal in high yield rather than propanoic acid.

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(2)

(b) Propan-1-ol is a volatile, flammable liquid. Give **one** safety precaution that should be used during the reaction to minimise this hazard.

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(1)

(c) A student followed the progress of the oxidation of propan-1-ol to propanoic acid by extracting the organic compounds from one sample of reaction mixture.

- (i) Give a chemical reagent which would enable the student to confirm the presence of propanal in the extracted compounds.
State what you would observe when propanal reacts with this reagent.

Reagent

Observation

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(2)

- (ii) Give a chemical reagent that would enable the student to confirm the presence of propanoic acid in the extracted compounds.
State what you would observe when propanoic acid reacts with this reagent.

Reagent

Observation

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(2)

(d) Predict which **one** of the compounds, propan-1-ol, propanal and propanoic acid will have the highest boiling point. Explain your answer.

Prediction

Explanation

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(3)
(Total 15 marks)

5

Many synthetic routes need chemists to increase the number of carbon atoms in a molecule by forming new carbon–carbon bonds. This can be achieved in several ways including

- reaction of an aromatic compound with an acyl chloride
- reaction of an aldehyde with hydrogen cyanide.

(a) Consider the reaction of benzene with $\text{CH}_3\text{CH}_2\text{COCl}$

(i) Write an equation for this reaction and name the organic product.

Identify the catalyst required in this reaction.

Write equations to show how the catalyst is used to form a reactive intermediate and how the catalyst is reformed at the end of the reaction.

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(5)

(ii) Name and outline a mechanism for the reaction of benzene with this reactive intermediate.

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(4)

(b) Consider the reaction of propanal with HCN

(i) Write an equation for the reaction of propanal with HCN and name the product.

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(2)

(ii) Name and outline a mechanism for the reaction of propanal with HCN

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(5)

(iii) The rate-determining step in the mechanism in part (b) (ii) involves attack by the nucleophile.

Suggest how the rate of reaction of propanone with HCN would compare with the rate of reaction of propanal with HCN

Explain your answer.

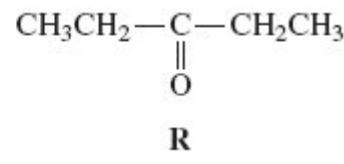
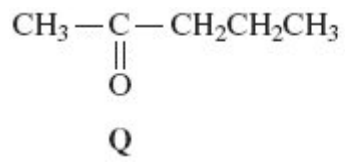
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(2)

(Total 18 marks)

6

Two isomeric ketones are shown below.



- (a) Name and outline a mechanism for the reaction of compound **Q** with HCN and name the product formed.

Name of mechanism

Mechanism

Name of product

(6)

- (b) Some students were asked to suggest methods to distinguish between isomers **Q** and **R**.

One student suggested testing the optical activity of the products formed when **Q** and **R** were reacted separately with HCN.

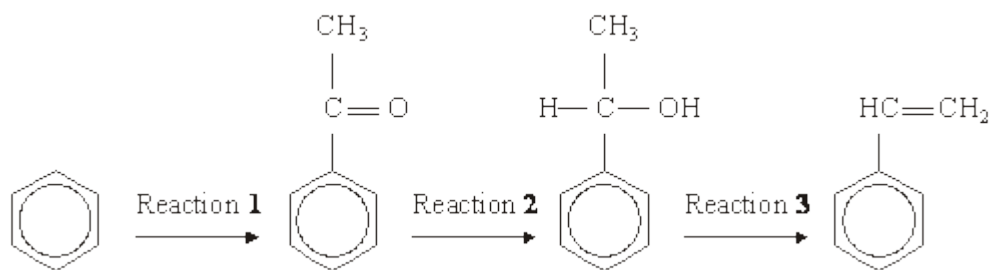
By considering the optical activity of these products formed from **Q** and **R**, explain why this method would **not** distinguish between **Q** and **R**.

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(3)
 (Total 9 marks)

7

A possible synthesis of phenylethene (*styrene*) is outlined below.



- (a) In Reaction 1, ethanoyl chloride and aluminium chloride are used to form a reactive species which then reacts with benzene.

Write an equation to show the formation of the reactive species.

Name and outline the mechanism by which this reactive species reacts with benzene.

(6)

- (b) NaBH_4 is a possible reagent for Reaction 2.

Name and outline the mechanism for the reaction with NaBH_4 in Reaction 2.

Name the product of Reaction 2.

(6)

- (c) Name the type of reaction involved in Reaction 3 and give a reagent for the reaction.

(2)

(Total 14 marks)